The impact of high yield irrigation wells on groundwater supplies in Western Kentucky: Involving stakeholders in the process of gathering information and managing this resource

Kentucky Division of Water, Watershed Management Branch

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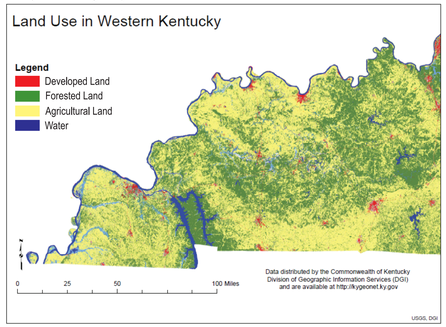
Introduction and Background

During the drought of 2012 diminished water quantity was observed in select areas in Western Kentucky. In particular, domestic well users alleged negative impacts to their groundwater levels due to overuse.

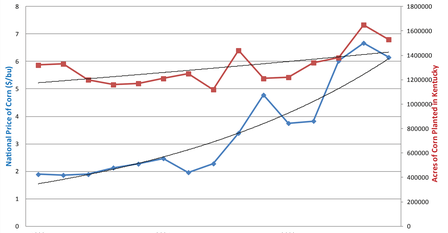
- Complaints generally limited to shallow, large diameter tile wells; many of which were known to have limited capacity.
- Agricultural water use is not regulated in Kentucky and there are not permitting or reporting requirements.
- Agricultural land use is steadily increasing in many areas of western Kentucky, along with the need for irrigation from surface water and groundwater sources
- Due to increased need for large-scale irrigation installation of center pivot systems has greatly increased

Kentucky Division of Water's (DOW) role is to protect water resources and provide water quantity and quality information to all users. This requires knowledge of the extent of groundwater use for various purposes, trends in well drilling numbers and accurate groundwater quantity and quality data.

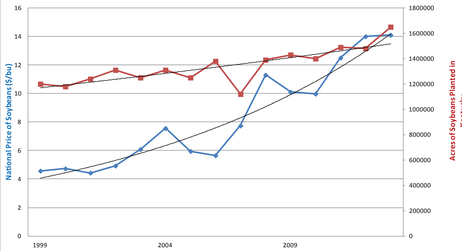
- Previous research by USGS and KGS delineated unique physiographic regions and corresponding aquifers throughout the state
- DOW maintains a database of known groundwater sources (wells and springs) and their use where reported
- Under current DOW regulations, water well drillers must submit a Well Construction Log that specifies the well use. However, these logs do not differentiate between irrigation system type



Simplified land use in western Kentucky based on the 2001 National Land Cover Dataset. Agriculture is the predominant land use throughout the region with smaller amounts of forested and developed lands.



Both corn and soybeans have dramatically increased in price over the past several years resulting in increased acreage of both commodities in Kentucky. This increase in price has also made large-scale irrigation affordable to more farmers resulting in the large increase in center pivot irrigation systems in the state.



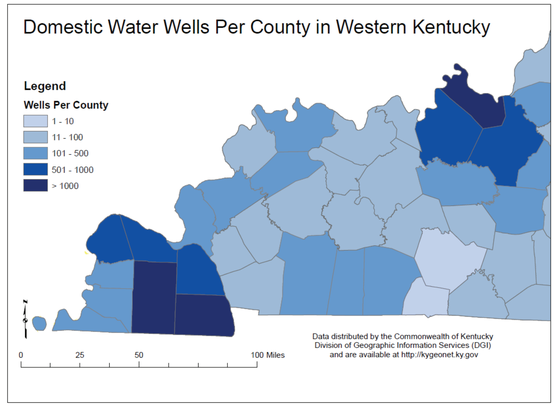
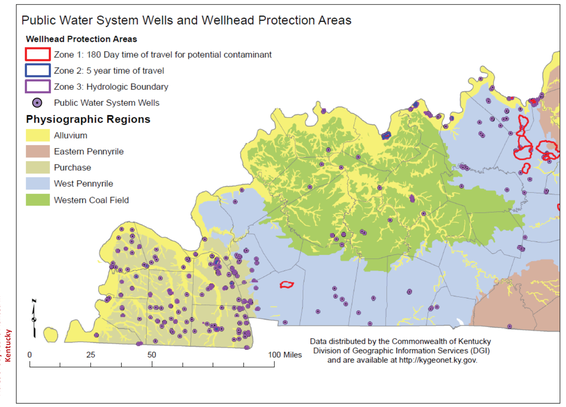


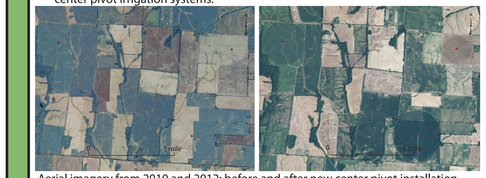
Figure illustrates distribution of known domestic water wells by county throughout western Kentucky. The groundwater database was initiated in 1985 with passage of 401 KAR 6:310 that requires well construction reporting. Therefore, many pre-law wells are not accounted for in the database. Actual well numbers for many counties would be much higher if all wells could be included.



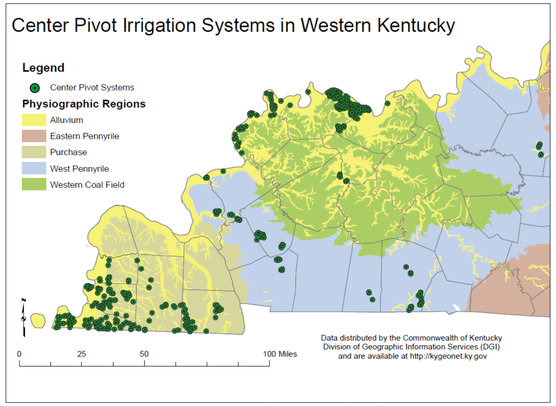
Map illustrates public water supply well locations and Wellhead Protection Areas in the region. Wellhead Protection Areas are required for any public water system utilizing groundwater as its source. Wells without associated protection areas most likely represent semi-public water systems or wells that are no longer used as the sole water supply for a business, school, or church.

Center Pivot Irrigation Systems by Region

- GIS and aerial imagery used to identify center pivot systems. To date, 415 center pivot irrigation systems have been identified in the study area using this method.
- Used site locations and records in the Kentucky Groundwater Database to hypothesize whether irrigation system source was surface water or groundwater.
- Currently estimate that 343 of the identified center pivot irrigation systems use a groundwater source (83%)
- Only 85 of the 607 irrigation wells in the study area were visually identified as center pivot irrigation systems.



Aerial imagery from 2010 and 2012; before and after new center pivot installation.



Jackson Purchase

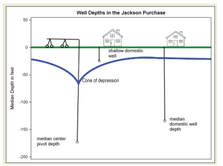
- Majority of area underlain by the Mississippi Embayment Aquifer System which are unconsolidated sediments
- The majority of identified center pivot irrigation systems withdraw water from wells pulling from either alluvium or deeper aquifers
- The number of center pivot irrigation systems has increased from 52 to 172 in the past 3 years (300% increase)
- Assuming an inch of water is applied in a week by each center pivot irrigation system an estimated 470,000,000 total gallons would be pumped a week to meet the irrigation demands.

Agriculture
- In this region farmers rely almost exclusively on groundwater to meet all of their water needs (irrigation, domestic use, etc.).

Domestic Well Users
- Region has one of the highest concentrations of privately owned domestic water wells.
- Majority of domestic wells are completed at depths similar to those used for irrigation systems.
- Numerous shallow, domestic wells (<50 ft. deep) in the region are susceptible to water supply problems in dry periods.

Public Water Systems (PWSs)
- There are a total of 64 PWSs in this region either producing or purchasing water from a groundwater source, serving approximately 112,259 people.

Potential Impacts
- Excessive groundwater use for irrigation could cause local depression of water table, which could impact shallow, domestic water wells.
- In most cases, publicly supplied water is not an option.



Possible irrigation effects on shallow domestic wells in the Jackson Purchase Region.

Western Coal Field

- Though other groundwater sources exist, the alluvium of the Ohio River and Green Rivers are the most accessible and only known sources used by center pivot irrigation systems.
- Identified center pivot irrigation systems are thought to mainly use shallow wells to withdraw water from the alluvium, with a few relying on surface water.
- There are 149 identified center pivot irrigation systems in the region.

Agriculture
- Limited competition from other user types for groundwater available in these areas.

Domestic Well Users
- Limited number of domestic well users in this region due to greater availability of public water supplies

Public Water Systems
- Western Coal Field: 4 PWSs in this region either producing or purchasing water from a groundwater source serving 7,539 people. Most groundwater PWSs utilize deeper sandstone aquifers in this region
- Ohio River Alluvium: 13 groundwater PWSs serving 115,957 people.

Potential Impacts
- Groundwater user types generally utilizing different aquifers and rarely in direct competition for resource.
- Potential negative impacts are limited.

Western Pennyrile

- Region is characterized by well-developed karst aquifers in the Mississippian-aged carbonate rocks.
- Significant springs, caves and other karst features provide access to an abundance of groundwater. Springs maintain base flow of streams during dry periods.
- Identified center pivot irrigation systems utilize surface water and groundwater resources.
- Only 94 center pivot irrigation systems have been identified.

Agriculture
- Rely on surface water and groundwater to meet irrigation needs.
- Access to groundwater generally limited to spring discharges, but some irrigation wells have intercepted cave systems.

Domestic Users
- Domestic groundwater use is very limited in this area due to PWS availability.

Public Water Systems
- Most PWSs rely on large rivers and reservoirs.
- 23 PWSs utilizing springs or wells and serving 190,302 people.
- Ohio River Alluvium: 12 groundwater PWSs serving 27,892 people.

Potential Impacts
- Due to groundwater's strong influence on surface water resources in this area, excessive groundwater withdrawals can negatively impact surface water systems. This can lead to diminished stream flow and concentration of nutrients and pesticides.
- Limited domestic well and spring users could be vulnerable to water supply issues during drought conditions.

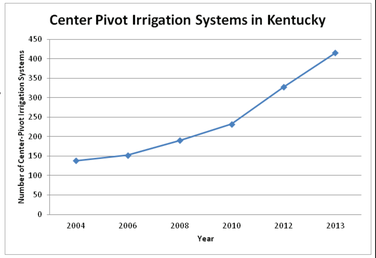
Stakeholder Communication

March 2013
- Survey was sent to drillers asking about installation of center pivot wells
- Response rate was poor
- Most responded they had not installed wells for center pivot irrigation

August 2013
- Meeting/panel discussion sponsored by Kentucky Farm Bureau with KGS, DOW, USDA and Ag producers
- A lot of interest was shown in irrigating with very little knowledge of approach
- Majority of Ag producers represented small to medium-sized operations and did not irrigate
- The few Ag producers that utilize irrigation own large-scale operations, withdrawing significant amounts of water

Conclusions

- Potential impacts to groundwater quantity due to competition by various users, and recent increases in irrigation. Shallow domestic wells in Jackson Purchase Region are most vulnerable, but groundwater users in other areas may observe problems during drought conditions.
- Multi-year drought and continued high corn prices could lead to more severe impacts across the study area.
- Potential for diminished stream flows in the Western Pennyrile Karst Region, especially during drought conditions.
- DOW currently does not have adequate data to draw meaningful conclusions about the impact of high-capacity irrigation on the quantity of groundwater available to all stakeholders.



The number of center pivot irrigation systems in Kentucky has tripled since 2004 with much of that increase happening in the past three years.

Recommendations

- A cooperative effort must be made to gather data about current irrigation sources and groundwater quantity in the study area. Partners include DOW, University of Kentucky, Cooperative Extension Services and Kentucky Geological Survey.
- Modify the Well Construction Record and Groundwater Database to identify the intended type of irrigation system for each water well.
- Increase enforcement of regulations on drillers that fail to submit water well records.
- Increase education and outreach to all private groundwater users (domestic and agricultural) on the effects of drought and the need for conservation.
- Kentucky Geological Survey is initiating a groundwater level monitoring network to better characterize groundwater quantity in the various aquifers of the state.

Acknowledgements and References

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